TABLE 2.—*Years of large departures of disturbing element*

Year	1874	1892	1894	1896	1902	1905	1909	1914	1915	1917	1919
Deviations ≧±1 mm. of Argentine pressure, April–June	1.3	2.4	1.5	1.5	−1.6	−1.0	1.3	−1.5	−1.4	1.2	−2.0
Deviations of the Nile flood, 3 months later:											
Actual	8	7	8	4	−6	−6	2	−3	−7	2	−3
Computed	4	7	5	5	−5	−3	4	−5	−4	4	−6

Regression on equation: $\Delta_{Nile}=3.1\ \Delta_{Press.}$

Contrast probability $=\frac{11}{11}=100$ per cent.

Year	1874	1878	1879	1887	1892	1894	1895	1899	1902	1905	1907	1913	1915
Deviations of the Nile flood ≧±6 or ≧±29 per cent	8	7	6	6	7	8	6	−6	−6	−6	−7	−12	−7
Deviations of German temperature following December–February° C.:													
Actual	−1.6	−1.0	−3.5	−1.8	−2.7	−3.1	−0.4	−0.5	0.6	1.2	0.2	0.9	2.8
Computed	−1.4	−1.3	−1.1	−1.1	−1.3	−1.4	−1.1	1.1	1.1	1.1	1.3	2.2	1.3

Regression equation: $\Delta_{Temp.}=-0.18\Delta_{Nile}$.
Contrast probability, $_{Nile}\geqq\pm6=12/13=92$ per cent.

Year	1874	1876	1877	1878	1885	1893	1901	1907	1908	1911	1917	1918
Deviations of the annual precipita- at Charleston ≧± 15 inches	15	30	30	29	20	23	−15	−16	−17	−16	−15	−17
Deviations of the North Atlantic circulation, 2½ years later, December–February:												
Actual	0	−10	−3	−17	−11	−2	6	8	2	3	10	1
Computed	−5	−10	−10	−10	−7	−8	5	5	6	5	5	6
Year	76/77	78/79	79/80	80/81	87/88	95/96	03/04	09/10	10/11	13/14	19/20	20/21

Regression equation: $\Delta_{circ.}=-0.34\Delta_{precip.}$
Contrast probability, $\Delta_{precip.}\geqq\pm15$, $=11/12=92$ per cent.

Year	1887	1892	1902	1906	1910	1915	1917	1919	1920
Deviations of May Argentine pressure ≧±2 mm	2.3	2.8	−2.3	−21.1	2.0	−3.1	3.7	−3.1	−2.1
Temperatures in east United States following September–November:									
Actual	−1.9	−2.1	1.9	1.0	−0.1	2.2	−3.4	1.7	1.4
Computed	−1.2	−1.4	1.2	1.1	−1.0	1.6	−1.9	1.6	1.1

Regression equation: $\Delta_{temp.}=-0.51\Delta_{press.}$
Contrast probability, $\Delta_{press.}\geqq$2mm., 100 per cent.

Year	1874	1876	1877	1878	1885	1893	1901	1907	1908	1911	1917	1918
Deviations of the annual precipitation at Charleston ≧± 15 inches	15	30	30	29	20	23	−15	−16	−17	−16	−15	−17
Deviations of temperature in Germany, March–May, 2¾ years later:												
Actual	−1.7	−1.6	0.3	−1.3	−1.5	−0.2	0.4	0.6	0.9	1.1	2.6	1.9
Computed	−0.7	−1.4	−1.4	−1.3	−0.9	−1.0	0.7	0.7	0.8	0.7	0.7	0.8
Year	1877	1879	1880	1881	1888	1896	1904	1910	1911	1914	1920	1921

Regression equation: $\Delta_{temp.}=-0.046\Delta_{precip.}$
Contrast probability, $\Delta_{precip.}\geqq\pm15$, 92 per cent.

Year	1874	1876	1877	1878	1885	1893	1901	1907	1908	1911	1917	1918
Deviations of the annual precipitation at Charleston ≧±15 inches	15	30	30	29	20	23	−15	−16	−17	−16	−15	−17
Deviations of the Nile flood 2 years later:												
Actual	4	7	6	2	6	6	0	2	−1	−12	−3	−3
Computed	3	7	7	6	4	5	−3	−4	−4	−4	−3	−4
Year	1876	1878	1879	1880	1887	1895	1903	1909	1910	1913	1919	1920

Probability $=10/12=83$ per cent.
Regression of equation: $\Delta_{Nile}=0.22\Delta_{precip.}$

NOTES, ABSTRACTS, AND REVIEWS

LAPSE RATE IN NIMBUS CLOUDS

By W. PEPPLER

(Abstracted from Meteorologische Zeitschrift, May, 1928, by W. R. Stevens)

The observational material upon which the author has based this study was obtained from the numerous captive-balloon ascents made over Lake of Constance between the years 1910 to 1927. In order to eliminate pure stratus clouds, only ascents were used which showed a cloud thickness of at least 2 kilometers. Furthermore, all records were eliminated which indicated a possibility of error due to ice deposit on the meteorograph or which showed discontinuities of temperature or humidity within the cloud. In this way we are assured of temperature gradients in homogeneous clouds. The temperatures and pressures given in the tables represent mean values over a range of 500 meters.

Table 1 shows the mean lapse rates with respect to certain temperatures without taking into consideration either height or pressure. N indicates the number of observations.

Above 3° C. the lapse rate is about 0.57. Between +1° C. and −1° C. there is a depression to 0.51, and at lower temperatures there is an approximately linear decrease to 0.68 at −14° C.

Table 2 shows lapse rates in nimbus clouds with temperatures and pressures as arguments.

At pressures less than 620 mm. (about 1,500 meters) the gradient decreases from 0.58 at 6° C. to 0.52 at −2° C. and increases at lower temperatures. Much the same conditions prevail at the other pressures considered.

When the mean temperature gradient is computed with respect to pressure, as in Table 3, almost the same gradient prevails between 480–660 mm.

It is seen from Tables 1–3 that the computed gradients in nimbus clouds do not coincide with those which theoretically should prevail. The difference (observed minus theoretical) between observed and theoretical values are given in Table 4.

At temperatures of 3° C. the observed and theoretical gradients correspond; but at temperatures near zero to −10° C. there is a uniform difference of about −0.06.

Table 5 shows the difference at various temperatures divided into three intervals of pressure and indicates much the same as Table 4.

Table 6 gives the percentage frequency of various differences between observed and theoretical gradients.

Small negative deviations between zero and −0.08 are most frequent. The question which naturally arises is whether the differences between observed and computed gradients are real and, if so, how they are to be explained.

The author lists four factors which may be responsible for the differences:

1. The vertical exchange of heat within the cloud through radiation. Since measurements are not available the order of magnitude is not known.

2. Absorption of solar radiation by the cloud, especially in the upper part.

3. The effect of precipitation which tends toward a diminution of the lapse rate. Even when no precipitation occurs the heavier drops sink and bring about an exchange of heat. This factor appears to be very important in decreasing the lapse rate.

4. Incomplete mixing of (*a*) air masses of different temperatures and (*b*) apparently homogeneous layers in which vertical motion and condensation has ceased.

The lapse rate was determined for three portions of each cloud and the following mean results obtained: Lower part, 0.58; central part, 0.60; upper part, 0.56. Theoretically we should expect a gradual increase with altitude. In this connection it may be of interest to quote from Suring in "Wissenschaftliche Luftfahrten":

> A relatively low lapse rate was found in the lower part of thick rain clouds above which was a layer approaching adiabatic—the principal condensation layer. Above the central portion, in spite of the sharply bounded surface, the clouds were so tenuous that sunshine penetrated far into them.

In the lower portion of a nimbus cloud there frequently exists a zone of mixing of different air masses, especially when the cloud lies directly above a surface of discontinuity, resulting in smaller lapse rate than would otherwise prevail.

The smaller lapse rate in the upper portion of the cloud seems to be a result of mixing of different air masses and the absorption of solar radiation. Since the upper portions of thick nimbus clouds usually consist of ice crystals, and since all the ascents were made during the day, the latter factor would be a very important one. It seems that at least 20 per cent of the total radiation would be absorbed by the cloud.

In conclusion the author brings attention to the following problems which need to be solved:

1. Temperature distribution in clouds, especially in regard to the difference between theory and observation, treated in this paper.

2. Vertical thermal structure of clouds; discontinuities which frequently occur in nimbus clouds, especially before and after precipitation within strata or as a result of convection.

3. Effect of radiation between cloud layers, especially in the upper portion and at the upper surface.

4. Distribution and magnitude of the factors of condensation; supersaturation and supercooling in clouds.

5. Atmospheric electricity in clouds, especially in case of manifold stratification, which would probably provide a key to the explanation of the sudden uniting of separate layers and the energetic condensation which ensues.

6. Measurement of temperature and humidity with the aspiration psychrometer in free balloons and at the same time with meteorographs in kites, captive balloons, or airplanes, especially at temperatures near zero, in order to determine whether the observations obtained by means of the meteorograph is correct. The importance of this question should be emphasized.

TABLE 1

T. (° C.)	10.0/6.1	6.0/4.1	4.0/2.1	2.0/0.1	0.0/1.9	−2.0/−3.9
dT./100	0.57	0.56	0.57	0.51	0.52	0.55
N	22	37	45	68	80	78
T	−4.0/−5.9	−6.0/−7.9	−8.0/−9.9	−10.0/−11.9	−12.0/−15.9	----------
dT./100	0.58	0.60	0.64	0.67	0.68	----------
N	65	57	32	25	18	----------

TABLE 2

T. (° C.)	8.0/4.1	4.0/0.0	−0.1/−4.0	−4.1/−8.0	<−8.1
>620 mm	0.58	0.55	0.52	0.63	----------
N	24	26	25	20	----------
620–570 mm	0.57	.054	0.53	0.58	0.64
N	28	61	73	58	33
<570 mm	----------	0.54	0.54	0.57	0.67
N	----------	28	53	40	33

TABLE 3

Pressure (mm.)	480/510	511/540	541/570	571/600	601/630	631/660
dT./100	0.56	0.57	0.57	0.57	0.57	0.57
N	16	35	101	126	158	80

TABLE 4

T. (° C.)	10.0/6.1	6.0/4.1	4.0/2.1	2.0/0.1	0.0/−1.9
Difference	+0.03	−0.01	+0.01	−0.06	−0.07
N	22	37	45	67	81
T. (° C.)	−2.0/−3.9	−4.0/−5.9	−6.0/−7.9	−8.0/−9.9	≦−10.0
Difference	−0.07	−0.07	−0.07	−0.06	−0.05
N	78	65	57	32	43

TABLE 5

T. (° C.)	8.0/4.1	4.0/0.0	−0.1/−4.0	−4.1/−8.0	<−8.1
>620 mm	+0.01	−0.02	−0.10	−0.04	----------
N	25	25	25	24	----------
620–570 mm	+0.01	−0.02	−0.08	−0.07	−0.09
N	26	63	75	61	34
<570 mm	----------	−0.03	−0.04	−0.08	−0.04
N	----------	27	55	41	33

TABLE 6

Difference	+0.25/0.20	+0.19/0.15	+0.14/0.10	+0.09/0.05	+0.04/0.00
Per cent	1.0	2.3	6.6	9.8	13.2
Difference	−0.01/−0.05	−0.06/−0.10	−0.11/−0.15	−0.16/−0.20	----------
Per cent	22.1	19.2	9.8	7.4	----------
Difference	−0.21/−0.25	−0.26/−0.30	−0.31/−0.35	<−0.36	----------
Per cent	4.7	2.3	0.9	0.7	----------

An engineering classic.[1]—In a paper recently presented to the American Society of Civil Engineers, Profs. S. M. Woodward and F. A. Nagler have given the profession an engineering classic. Their paper is an analysis of fact so keen and at the same time so fair and judicious in both method and conclusion as to constitute a model of engineering induction. If these qualities give it an exceptional fascination to the inquiring mind, its strength of appeal is further heightened by the subject, which is one of the most perplexing factors surrounding floods and flood protection.

Serious attention to the destructive power of floods and how to guard against them has been long delayed. Little real engineering study was given to the matter until about twenty years ago, and not until the phenomenal rainfall that deluged the belt of country north of the Ohio River in 1913 did flood protection gain a place in the first rank of engineering problems. Even after this period, and in spite of a steady repetition of flood disasters, the public remained apathetic except

[1] Reprinted from Engineering News-Record July 5, 1928.

locally in the wake of great destruction, as at Pueblo. The great flood in the lower Mississippi in 1927 finally translated the problem into such huge proportions as to assure the subject permanent attention.

There are ordinarily long intervals between great floods, and since all American river-flow records are short there is a tendency for higher floods than any on record to make their appearance. Further, land culture and river-bank settlement modify stream flow. Under these conditions of complication, various men have been inclined to single out either one or another factor in the situation as decisive, and develop correspondingly individual theories of flood prevention.

Thus, deforestation was widely blamed as a cause of increased flood height. Others saw the chief source of trouble in the extension of land cultivation and the coincident reduction in soil cover. Soil erosion and flood incidence were correlated by others, who therefore advocated contour plowing. And, finally, land drainage was charged by many with a material contribution to floods. Following the Mississippi Valley flood of last year in particular, drainage was brought in to the argument and by implication a distinct share in the destruction wrought in the lower valley was assigned to those progressive agricultural States along the upper and middle course of the river which had developed drainage most largely. It is this question of the influence of drainage upon floods that the paper in question finally places on a basis of definite proof by fact. Unreasonable as the argument of drainage influence was—since the increased soil-reservoir storage resulting from the lowering of ground-water level due to drainage could only operate to retard run-off—it yet was sufficiently persistent and influential to have a seriously confusing effect on proper understanding of the flood problem. By laying the ghost of drainage, Professors Woodward and Nagler thus contribute greatly to the advance of flood study.

The method which they adopted in their analysis is intensely instructive. Briefly, they first studied the records of the development of land drainage in the upper Mississippi Valley, and found two large regions in which drainage has been so far developed as to affect a large fraction of the potential run-off. The beginning of drainage development, however, was considerably later in the more westerly of the two regions, so that substantially the whole development of drainage here occurred within the past 20 years. On two large rivers which drain this region, careful flow observations have been made since before drainage began. Accordingly this region, in central and northern Iowa, was selected for the study.

Prior to 1905, organized drainage work in this region was not very extensive, due to lack of suitable legislative authorization. The great bulk of the work was comprised in the 10-year interval, 1907–1917. A 4-year record of stream flow, 1903–1906, was accordingly taken as representative of flood relations prior to drainage, while the 6-year period 1918–1923 was taken to represent conditions with drainage. The total contributing areas above the several stream-gauging points range from 3,000 to 14,000 square miles, and the drained fractions range from more than one-third to substantially the whole of the area, for the later period of stream-flow comparison. The case thus selected for the study is remarkably well adapted to the purposes of the inquiry; nowhere else in the country could equally favorable conditions for the comparison be found, as the authors well emphasize.

Since rainfall conditions and flood probabilities in the two selected flood-flow periods were in all likelihood quite dissimilar, the investigators made their analysis by studying particular storms and their run-off. Preliminary comparisons of monthly run-off with monthly precipitation during the spring months showed rather widely scattering results, but the scatter areas for the predrainage and post-drainage periods coincided fairly well. Next, every storm that produced a flood exceeding a certain minimum was analyzed; again the plotted points showing relation of flood run-off to precipitation fitted closely together for the two periods. Thus the anlysis almost incontrovertibly proved that drainage has caused no measurable difference in total run-off. The same thing was found for peak rate of flow, the results again grouping closely enough to furnish a definite test of the question at issue. Thus drainage also has not increase the peak flow of floods.

Though these results afforded conclusive proof, the authors carried their analysis still farther by applying a more delicate test of change in the water-retentive power of the stream basin due to drainage. This test was found in a comparison of the rate of decrease ot flow after the flood peak, which decrease would obviously be more rapid for the less retentive condition; that is, if drainage caused the water to discharge into the stream more rapidly, the flood wave should ebb away more rapidly after its peak than it did in the undrained condition of the land. But the comparison showed no difference, and it could only be concluded that the watershed was fully as retentive after drainage as before.

In demonstrating that land drainage has had no detectible effect upon flood flow in rivers, the authors build up their proof from data selected with the utmost care to get a fair comparison, and their analysis utilizes these data with the highest degree of ingenuity and incisiveness. Their findings, as we said above, will be of distinct assistance in fostering sound engineering thought on flood protection. Even beyond its value in this respect, however, their studies will long stand as a classic example of scientific engineering analysis.

World Weather, Part III, G. T. Walker and E. W. Bliss [1] *(Roy. Met'l. Soc. Mem. 2, 17, pp. 97–134, April, 1928.*—The present paper forms a continuation of two papers in the Indian Meteorological Memoirs (vol. 24, parts 4 and 9), and extends the tables of relations between 20 centers of action to those between 32 centers. Of the new centers 9 deal with temperatures, 2 with pressures, 1 with Nile floods, 1 with ice in the Barents Sea, while 1 old center is abolished. The relationships between the centers may be expressed most simply in terms of three systems, the Southern oscillation, the North Atlantic oscillation, and the North Pacific oscillation. The nature of the relations with the oscillations are tabulated, the degree of closeness being shown numerically and the signs + or − used to indicate growth with an increase or decrease of the atmospheric circulation. Of the new centers the temperatures of Batavia and Samoa and the Nile floods are very important in the Southern oscillation, Samoa having in all in the four quarters 37 coefficients of 0.6 or over, Batavia temperature 78 "significant" coefficients during the year and the Nile 31 in one season. The oscillations are not regarded as controlled by sun spots numbers but as systematic swayings of interconnected world conditions which are slightly intensified or checked by solar conditions.—*R. S. R.*

New rainfall and temperature map of North Carolina.—A large shaded map of annual rainfall with annual isotherms and also drainage basins and gauging stations printed on it has been prepared by Charles E. Ray under the supervision of Thorndike Saville and published by the

[1] Reprinted from Science Abstracts, Aug. 25, 1928.

water resources division of the North Carolina department of conservation and development. It constitutes Plate I of Economic Paper 61 (1928). While the features of the rainfall do not stand out clearly owing to the other items on the map, the heavy rainfall of over 80 inches on the southwestern highlands and the moderate rainfall of under 40 inches in the valley in the rain shadow to the north are in evidence. In the east the rainfall is moderately heavy, 50 to 55 inches being most prominent, though less than 50 and even under 45 occupy belts inland and on the southern portion of the coast. The mean annual temperatures range from under 50 in the extreme northwest to over 63 in the southeast. The bases for these isohyets and isotherms are the full records from the climatological stations in the State. A more comprehensive study of the rainfall, including due consideration of homogeneity of the years of record, is in preparation.—*C. F. B.*

Proposed meteorological service for East Africa.—Mr. Charles H. Albrecht, American consul at Nairobi, Colony of Kenya, Africa, communicates the following—

"The establishment of a meteorological service embracing British East African territories and Egypt and linking up with similar services in other parts of the world is foreshadowed in a memorandum which has been circulated to members of the Kenya Legislative Council.

"Some of the benefits of the service, the cost of which would be met by the various territories concerned, would include a permanent survey of climatic conditions affecting human and crop disease, insect pests, the ascertainment of the relation of climate to reafforestation problems, rainfall forecasts, and the best routes for air services."

Meteorological summary for Chile, August, 1928 (by J. Bustos Navarrete, Observatorio del Salto, Santiago, Chile).—There was some increase in the activity of atmospheric circulation, especially in the second half of the month. The chief depressions were those of the 4th–6th, with rain north to Concepcion; 15th–16th, with rain north to Curico; 21st–24th, with scattered rains in central and southern regions; 25th–27th, with squally weather north to Valparaiso; and 29th–31st, with rain north to Arauco.

Periods of fine weather accompanied the high-pressure areas charted as follows: 1st–5th, 7th–12th, and 17th–22d.

Total precipitation for August: Santiago, 0.32 inch; Valdivia, 6.98 inches.—*Translated by W. W. R.*

BIBLIOGRAPHY

C. FITZHUGH TALMAN, in Charge of Library

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Crestani, Giuseppe.
Il clima dei Colli Euganei e di Padova. Roma. 1928. 42 p. 27½ cm.

France. Office national météorologique.
Météogrammes régionaux France. 9ème ed. (En vigueur le 13 août 1928.) Paris. 1928. v. p. 28 cm.

Grosse, W.
Wetterkunde. Berlin. 1928. 299 p. illus. plates. 24 cm.

Hayes, James Gordon.
Antarctica; a treatise on the southern continent. London. [1928.] xv, 448 p. front. plates. maps (part fold.). diagrs. 26 cm. [Chapter 4, Meteorology.]

Hoffman, G., & Lindholm, F.
Registrierbeobachtungen der Hessschen Ultra-γ-Strahlung auf Muottas Muraigl (2456 m.) Leipzig, 1928. p. 12–54. illus. 22½ cm. (Sonderdr.: Gerlands Beiträge zur Geophysik. Bd. 20.)

Kidson, E.
Sun-spot numbers and annual rainfall in New Zealand. Wellington. 1928. p. 90–97. fig. 25 cm. (New Zealand journ. sci. & tech. v. 10, no. 2, 1928.)

Kimball, Herbert H.
Distribution of energy in the visible spectrum of sunlight, skylight, and the total daylight. 16 p. figs. 23 cm. (Internat. comm. on illum., 7th meeting, Saranac inn, N. Y., Sept. 22–28, 1928.)

Leighly, John B.
M. F. Maury and the theory of the general circulation of the atmosphere. p. 49–60. fig. 23½ cm. (Repr.: Cent. state teachers coll. studies, no. 1. June, 1928. Mount Pleasant, Mich.)

Manley-Bendall, M.
Les galernes du golfe de Gascogne. p. 791–793. 27½ cm. (Bull. Soc. d'océan. de France. 8e année. 15 juil. 1928.)

Meldau, H.
Technische Navigation und Meteorologie. Unter Mitwirkung von F. U. Fischer, T. Georgi und H. Maurer. Bremen. 1927. 176 p. figs. tables. 25 cm. (Nachtrag zur 10. Auflage.) (Breusing-Meldau/Steuermannskunst. Im Verein mit O. Fulst und C. Schilling, herausgegeben von H. Meldau.)

Mortensen, Hans.
Der Formenschatz der nordchilenischen Wüste. Ein Beitrag zum Gesetz der Wüstenbildung. Berlin. 1927. viii, 191 p. illus. plates (part fold.) 25½ cm. (Abhandl. Gesellsch. der Wissensch. zu Göttingen. Math.-phys. Kl., neue Folge Bd. 12, 1.)

Reichel, Eberhard.
Abfluss und Verdunstung im Coloradogebiet. Stuttgart. 1928. 31 p. fig. plate (fold.) 22½ cm. (Inaug.-Dissert., Friedrich-Wilhelms-Univ. zu Berlin.)
Die Wasserhaushalt des Coloradogebietes im südwestlichen Nordamerika. Mit einem Anhang Untersuchungen über die Denudation dieses Gebietes, von M.-Mercedes Leiter. Stuttgart. 1928. 81 p. figs. 23½ cm.

Terada, Torahiko, & *others*.
On gustiness of winds. ii, p. 235–270. figs. plates. 26 cm. (Report Aeron. res. inst., Tôkyô imp. univ. no. 38. June, 1928. (v. 3, 8.))

Uruguay. Observatorio nacional.
Sondeos de la atmósfera en Montevideo. Año 1927. Montevideo. 1928. 28 p. 28½ cm.

Wells, Edward Lansing.
Some fundamental facts in meteorology. Portland, Ore. n. d. v. p. illus. 20 cm. (Prepared for Rankin flying school.)

Zsigmondy, Emil, & Paulcke, Wilhelm.
Die Gefahren der Alpen. 8te. Aufl . . . München. [1927.] 361 p. illus. plate. port. 21 cm. [Contains chapters on weather.]